REMARKS

Claims 1 to 11 are pending in the application.

The purpose of this amendment is to insert the reference to the parent application of which this is a continuation, place the application headings in appropriate U.S. form, and generally place the specification and claims in appropriate U.S. form. Such amendments are formal in nature and no new matter is added by any of the above amendments. A marked-up copy of the substitute specification is enclosed to reflect these amendments. Entry of this amendment and early examination of this application are respectfully solicited.

Respectfully submitted,

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(Date)

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Enclosure

Marked-up Version of Substitute Specification

~~"METHOD FOR PRODUCING THERMO-INSULATING CYLINDRICAL VACUUM PANELS AND PANELS THEREBY OBTAINED"~~

TITLE OF THE INVENTION

[0001] Method for Producing Thermo-Insulating Cylindrical Vacuum Panels and Panels Thereby Obtained

CROSS-REFERENCE TO RELATED APPLICATIONS

[0002] This application is a continuation of International Application No. PCT/IT02/00808, filed December 19, 2002, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0003] The present invention relates to a method for producing thermo-insulating cylindrical vacuum panels and to the panels thereby obtained.

[0004] Vacuum panels, and particularly those made with plastic materials, are being increasingly used in all the fields ~~wherein a thermo-~~where thermal insulation at temperatures lower than about 100 °C is required. As examples of such applications can be mentioned the walls of domestic and industrial refrigerators, of the beverages dispensing machines (~~wherein thermo-~~where thermal insulation is required mainly in order to separate the portion ~~of~~for the hot drinks, generally at about 70 °C, from that of the cold drinks), or of the containers for isothermal transportation, for example of drugs or cold or frozen food. Applications of these panels are being studied also in the building field or in the car industry.

[0005] As known, a vacuum panel is formed of an envelope inside which a filling material is present. The envelope has the function of preventing (or reducing as much as possible) the inlet of atmospheric gases inside the panel, so as to keep ~~a~~the degree of vacuum ~~grade~~ compatible with the ~~thermo-~~thermal insulation level required by the application. ~~To~~For this purpose, the envelope is made with so-called "barrier" sheets~~,~~ of thickness generally not greater than 100 μm, characterized by a gas permeability being as low as possible. These sheets can be formed of a single component, but more frequently are multi-layers of different components~~; in~~. In the case of multilayers the barrier effect is conferred by one of the component layers (generally metallic and commonly ~~of~~ ~~aluminium~~aluminum), whereas the other layers generally have functions of mechanical support and protection of the barrier layer.

[0006] The filling material has the function of spacing apart the two opposite faces of the envelope when vacuum is created in the panel. This filling material can be inorganic, such as silica

powder, glass fibers, aerogels, diatomaceous earth, etc., or organic, such as rigid foams of polyurethane or polystyrene, both in the form of boards and of powders. Materials more commonly used are open ~~cells~~celled polyurethane foams (open cells are necessary to allow their evacuation through mechanical pumping) and, in the case of panels which must resist ~~to~~ temperatures higher than about 150 °C, silica powder (generally of ~~submicronic~~sub-micron dimensions). The filling material must in any event be ~~anyway~~ porous or discontinuous, so that the pores or the interstices can be evacuated. Since the permeation of traces of atmospheric gases into the panel is practically unavoidable, these panels contain in most cases also one or more materials (generally referred to as getter materials) capable of sorbing these gases, so as to maintain the pressure inside the panel at the desired values.

[0007] Vacuum panels generally have a planar configuration and can hence be used to insulate substantially parallelepiped bodies, having planar surfaces, but they are not suitable for bodies having substantially cylindrical walls, such as for example bath-heaters or the ~~pipings~~pipes used for oil transport in the arctic regions.

[0008] One of the methods used so far to obtain the ~~thermo-~~thermal insulation of bodies having non-planar surfaces consists in connecting to each other several flat panels in the shape of bands, for example by gluing ~~together~~ their edges together, thus obtaining a composite structure which can be bent along the junction lines so as to adapt it to the shape of the body which has to be insulated. However, in this kind of ~~structures~~structure heat ~~transfers take~~transfer takes place at the junctions, and therefore the quality of the heat insulation at these zones is poor~~; furthermore~~. Furthermore, a structure made up of planar parts can only approximate a curved surface~~, hence~~. Hence, there are areas of scarce contact between the panel and the body to be insulated, with formation of air chambers and, again, decreasing ~~of~~ the efficiency of the insulation.

[0009] International patent application publication WO96/32605 in the name of the British company ICI describes rigid vacuum panels having a non-planar shape and a method for the manufacture thereof, which consists in making ~~in the filling material~~ grooves arranged in a desired direction in the filling material and having suitable width and depth. Subsequently, the filling material is inserted into an envelope, and the assembly is subjected to the evacuating step. Finally, the evacuated panel is sealed. A thus produced panel, at its first exposure to the atmosphere, spontaneously bends along the grooves formed in the filling material.

[0010] This production method has however some drawbacks. First of all, it has been observed that in the course of ~~said~~the evacuation the envelope adheres to the filling material and becomes at least partially inserted into ~~said~~the grooves so that, when the evacuation is completed, the thickness

of the panel is not uniform in all the parts thereof, but is lower at the bending lines with respect to the planar portions of the same panel. Consequently, ~~also the thermo-~~the thermal insulation properties are also not uniform, but are reduced along these bending lines. Moreover, another drawback consists in the risk of ~~cracks~~crack formation in the envelope, which is pressed inside the grooves, thus enabling the passage of atmospheric gases towards the inside of the panel, which permanently compromises ~~permanently the properties of thermo-~~the thermal insulation properties of the panel itself. Finally, as the bending of these panels occurs spontaneously during the first exposure to air, the panels occupy a notable volume soon after production, which makes ~~it economically very onerous~~ their storage and transportation economically very onerous. Another inconvenience of the method of the above mentioned international application is that it can be used only when the filling material is a board, for example of a polymeric foam, but not in the case of discontinuous materials such as powders or ~~fibres.~~ fibers.

BRIEF SUMMARY OF THE INVENTION

[0011] Therefore, an object of the present invention is to provide a method for producing thermo-insulating cylindrical vacuum panels, as well as to provide the resulting panels, which are free from the drawbacks of the prior art.

[0012] ~~Said~~The objects are achieved according to the present invention, which in a first aspect thereof relates to a method for producing thermo-insulating cylindrical vacuum panels comprising the steps of:

–manufacturing a planar vacuum panel according to any known procedure; and

–curving the panel through calendering.

[0013] The operation of calendering is well known and applied in the mechanical field for curving metallic plates, that is, plates of materials having features of plastic deformation. ~~Inventors~~The present inventors, however, have found that this operation can be successfully applied also in the case of vacuum panels. This possibility was not foreseeable because of the discontinuity of the filling materials of the panels, a characteristic which does not allow ~~to evaluate previously~~previous evaluation of the mechanical properties (particularly the deformation behavior under mechanical stress)~~; furthermore~~. Furthermore, in case of panels filled with polymeric foams, these are generally fragile, and the breaking of the foam board could have been expected

[0014] The term "cylinder" and ~~the derived~~ terms derived therefrom, as used in the present ~~invention~~application, have a broad meaning~~, that~~. That is, they may ~~be referred~~refer to cylindrical surfaces having a base with constant ~~curving~~ radius of curvature (that is with circular base,

according to the more common use of the term), but also with variable ~~curving~~ radius of curvature (for example, ellipsoidal or irregularly shaped).

[0015] ~~The invention will be described in the following with reference to the drawings wherein:~~

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0016] The foregoing summary, as well as the following detailed description of the invention, will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, there are shown in the drawings embodiments which are presently preferred. It should be understood, however, that the invention is not limited to the precise arrangements and instrumentalities shown. In the drawings:

[0017] ~~-fig~~Fig. 1 ~~shows~~is a sectional view of the calendering operation of an originally planar panel~~;~~ according to the present invention; and

[0018] ~~-fig~~Fig. 2 ~~shows~~is a top perspective view of a finished cylindrical panel according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0019] Panels to be subjected to calendering can be of any known type, obtained through any combination of ~~kind~~type of envelope and filling material, with or without getter material. The production of planar vacuum panels is well known~~; for~~. For a description of these panels and of methods for the production thereof ~~it~~, reference is made to ~~be referred to a~~ broadly available literature, among which are, for example ~~patents US~~, U.S. Patent 4,726,974 and ~~US~~U.S. Patent 5,943,876, and published patent applications WO96/32605, EP-A-437930 and JP-A-7-195385.

[0020] ~~Lateral dimensions of planar~~Planar panels to be used can ~~be anyone~~have any lateral dimensions, while the thickness ~~has~~ generally has a maximum value depending on the filling material~~; obviously~~. Obviously, there is not a lower thickness limit required by the possibility of carrying out the calendering operation, but the thickness of the panel must be such as to ensure good ~~thermo-~~thermal insulation properties, which would require the use of relatively high thickness values. The thickness values ~~really~~actually used are derived from ~~the~~a compromise between these two opposite needs~~; for~~. For example, in the case of polyurethane foam boards, the thickness is generally ~~lower~~less than 20 mm, preferably ~~comprised~~ between 8 and 15 mm~~; in~~. In the case of panels with a filling of silica powder, the thickness can vary between about 5 and 20 mm.

[0021] The calendering operation is carried out according to ~~the~~ procedures known in the mechanical field, by passing the planar vacuum panel between at least two rollers and a third

element ~~of~~having a length ~~equal~~ at least equal to that of the rollers and placed parallel to the "nip" between the first two rollers~~; this~~. This third element is, generally, a third roller. As already known, by properly adjusting the position of the third element, and in particular its distance with respect to the nip between the first two rollers and its height from the geometrical plane containing the still flat portion of the body to be curved, it is possible to determine the ~~curving~~ radius of curvature of the final product.

[0022] The operation is schematically shown in section in ~~figure 1: vacuum~~Fig. 1. Vacuum panel 1 is moved forward from right to left by the ~~co-ordinate~~coordinated moving of rollers 2 and 3 (whose direction of rotation is indicated by arrows), and is forced to slide on the third roller 4, which curves it upwardly giving a ~~curving~~curvature of radius R. The ~~curving~~ radius of curvature decreases when roller 4 is moved toward the right (getting it nearer to the nip between rollers 2 and 3) or upwardly in the drawing~~, and on~~. On the ~~contrary~~other hand, it increases with opposite movements. Cylindrical panels having a non circular base can thus be obtained by modifying the position of roller 4 continuously during the calendering operation ~~the position of roller 4 as~~ described above.

[0023] The calendering operation can even be carried out simultaneously on the planar panel and on another element, ~~such as~~ for example a layer of an adhesive polymeric foam placed on one face of the panel (or on both ~~of them~~faces). In this case, ~~it is obtained~~ a cylindrical panel is obtained which ~~has~~ already~~,~~ has on one of its external or internal surfaces (or both) a layer of adhesive material, useful for fixing the same panel to a wall of the interspace intended to contain it. This interspace can be, for example, that of a concentric double tube ~~piping~~pipe for isothermal transportation of petroleum, to prevent its heavy fraction from condensing in cold areas ~~obstructing the piping; or interspaces~~, which would obstruct the pipe. It could also be an interspace of boilers, for example of water-heaters for domestic use, to reduce the thermal dissipation for ~~energetic~~ energy-saving purposes. To help the fixing of the panel to a wall of the interspace, it is preferable that it ~~has~~have a ~~curving~~ radius of curvature slightly different from ~~the one~~that of ~~said~~ the wall, and in particular slightly ~~lower~~less, if the surface of the cylindrical panel to be put in contact with the wall is ~~the~~an internal one, and vice versa.

[0024] The method of the invention has, in particular, the advantage that the panels can be bent, with ~~a~~ simple and ~~cheap~~inexpensive equipment, just before they are fixed in the final utilization place~~; hence~~. Hence, the transportation or the storage of ~~big~~large volume products at the store of the manufacturer or of the final user, is not required.

[0025] ~~Figure~~Fig. 2 shows a vacuum panel, 5, bent according to the method described up to this point. This is different from the panels of the ~~international~~International published patent application

WO96/~~32605~~32605, especially because it ~~has~~does not have grooves on the internal surface, and thus has more uniform properties of ~~thermo-~~thermal insulation.

[0026] It will be appreciated by those skilled in the art that changes could be made to the embodiments described above without departing from the broad inventive concept thereof. It is understood, therefore, that this invention is not limited to the particular embodiments disclosed, but it is intended to cover modifications within the spirit and scope of the present invention as defined by the appended claims.

CLAIMS

I/we claim:

1. A method for producing cylindrical vacuum panels comprising the steps of:
   –producing a planar vacuum panel according to any known procedure; and
   –curving the panel ~~through~~by a calendering operation.

2. ~~A~~The method according to claim ~~1~~1, wherein ~~said~~the calendering operation is carried out by passing the planar vacuum panel between at least two rollers (2, 3) and a third element of length equal at least to ~~that~~a length of the two rollers and ~~placed~~positioned parallel to ~~said~~the two rollers.

3. ~~A~~The method according to claim ~~2~~2, wherein ~~said~~the third element is a third roller (4).

4. ~~A~~The method according to claim ~~1~~1, wherein ~~said~~the planar vacuum panel comprises, as filling material, a rigid polyurethane foam, and has a thickness ~~lower~~less than 20 mm.

5. ~~A~~The method according to claim ~~4~~4, wherein ~~said~~the panel has a thickness ~~comprised~~ between 8 and 15 mm.

6. ~~A~~The method according to claim ~~1~~1, wherein ~~said~~the planar vacuum panel comprises, as filling material, silica powder, and has a thickness ~~comprised~~ between about 5 and 20 mm.

7. ~~A~~The method according to claim ~~2~~2, wherein the position of ~~said~~the third element is continuously modified during the calendering operation.

8. ~~A~~The method according to claim ~~1~~1, wherein ~~said~~the calendering operation is carried out simultaneously on the planar panel and on at least a layer of an adhesive polymeric foam placed on at least one surface of the panel.

9. A cylindrical vacuum panel (5) obtained according to the method of claim 1.

10. A cylindrical vacuum panel ~~with~~obtained according to the method of claim 8 having at least ~~a~~one layer of an adhesive polymeric foam adhering to at least one surface of the panel, ~~obtained according to the method of claim 8.~~.

11. A cylindrical vacuum panel ~~with non-~~obtained according the method of claim 7, having a non-circular curving base ~~obtained according the method of claim 7.~~.

ABSTRACT OF THE DISCLOSURE

~~It is disclosed a~~A method is provided for producing thermo-insulating cylindrical vacuum panels starting from planar panels~~, which comprises~~. The method includes subjecting the planar panel (1) to a calendering operation~~,~~ by passing it through at least two rollers (2, 3) and a third element (4).

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